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CHINA REPORT

SCIENCE AND TECHNOLOGY

CONTENTS

PEOPLE'S REPUBLIC OF CHINA

NATIONAL DEVELOPMENTS

BRIEFS

MARINE DEVELOPMENT RESEARCH DRIVE--Beijing, June 11 (XINHUA)--China has launched a nationwide marine development research drive. Sponsored by the State Council's research center for technology-economy and the State Bureau of Oceanography, the research will lay a foundation for the formulation of a national long-term marine development program and related policies. The research covers the role of marine development in the growth of social economy, the status quo of marine development in China, its trend in the world and the challenge China is to face; marine industries including fishery, shipping, salt making, off-shore oil and gas exploration, utilization of seawater, energy and deep-sea mining as well as marine survey and management and personnel training. More than 250 scientists will work under a committee of 34 consisting of the country's leading oceanologists. Marine biologist Zeng Cheng-kui and marine acoustician Wang Dezhao are on the committee. The work is expected to be completed within a year. Results will be published. China has vast territorial waters, 18,000 kilometers of continental coastline. [Text] [OW110732 Beijing XINHUA in English 0646 GMT 11 Jun 84]

INSTITUTE FOR POLAR REGIONS--Beijing, June 9 (XINHUA)--A China institute on polar regions is to be established in Shanghai, the China National Committee for Antarctic Research announced here today. The building would be completed in 1987. The institute's major tasks will be planning annual and long-term antarctic research, investigating the resources and energy value of polar regions, analyzing and storing specimens collected in Antarctica, publishing papers on antarctic research and conducting international academic exchanges and cooperation. To improve survey work, the National Meteorological Bureau has set up a laboratory of antarctic meteorology in Beijing, and the State Bureau of Oceanography has established an antarctic research group in Hangzhou. Since 1980, the National Committee for Antarctic Research has sent 32 Chinese scientists to Antarctica. Four Chinese scientists are now at three antarctic stations of Australia and Argentina. [Text] [OW091216 Beijing XINHUA in English 1200 GMT 9 Jun 84]

ARCHEOLOGIST RECOGNIZED FOR CONTRIBUTIONS--Beijing, May 28 (XINHUA)--Professor Xia Nai, a noted Chinese archeologist, has been elected as a foreign associate of the U.S. National Academy of Sciences in recognition of his significant contributions to science, according to the Chinese Academy of Social Sciences here today. He was informed of the honor in a letter from foreign secretary of the U.S. academy, Walter A. Rosenblith, earlier this month. Professor Xia Nai, now 74, is vice-president of the Chinese Academy of Social Sciences, honorary

director of the Institute of Archeology and president of the Chinese Society of Archeology. He has been engaged in archeological research for 50 years and has published over 200 scholarly works, including "Collection of Academic Papers on Archeology" and "Archeology and the History of Science and Technology." Since 1973, Professor Xia has received honorary titles from six universities and research institutes in Britain, the Federal Republic of Germany, Peru and Sweden. [Text] [OW281424 Beijing XINHUA in English 1413 GMT 28 May 84]

CSO: 4010/93

COMPACT MARX GENERATOR DESCRIBED

[Article by Cheng Nian'an [4453 1819 1344], Gao Yudong [6750 3768 2767], and Zhang Shouyun [1728 1108 0061]: "A Compact 1 MV Marx Generator"]

[Text] The main requirement for a pulsed high-voltage source for use in generating a high-current electron beam is that it have low inductance and be reliable. The 1 MW compact Marx generator described in this paper was developed for use as such a high-voltage pulsed power source. It may also be used as a high-voltage power source for generating pulsed X-rays or in exploding-wire experiments. It uses capacitors for storage; a high-voltage DC power source charges the capacitors in parallel, and when the control switch is triggered, the capacitors discharge in series, producing high-voltage pulses. Because of the design used, the device is compact and small. The nominal output voltage is 1 MV, and the storage capacity 6 kJ. Long-term testing extending over several years has indicated that it has good characteristics and is stable and reliable.

1. The Main Body of the Generator

The generator makes use of the usual Marx circuitry, as illustrated in Fig 1. It has a total of 10 stages, each stage having a capacitance of 0.12 μF; the rated DC charging voltage is 100 kV and the generator's nominal output pulse voltage is 1 MV. The capacitors are arranged close together in rows, and the spherical discharge gap for all stages are clustered close together inside a cylindrical tube; the charging resistors (R_c) and charging ground resistors (R_g) are copper sulfate-water resistors. These components make up the main body of the generator, and are all immersed in oil in an iron box. Fig 2 shows a general view of the generator (inside the oil box). The high-voltage DC input terminal is at the top of the picture and the high-voltage pulsed output terminal at the bottom. The voltage divider can be installed at the output end to measure and monitor the generator's output voltage.

Multiple-baffle oil insulation is used between the body of the generator and the walls of the oil box; this further decreases the dimensions of the oil box and increases the energy storage density. In addition, in order to remove air bubbles from the oil, it is introduced under vacuum; in order to increase the mechanical strength of the oil box, a lattice of channel steel reinforcing ribs is welded to its exterior.

Figure 1. Circuitry of the 1 MV Marx Generator
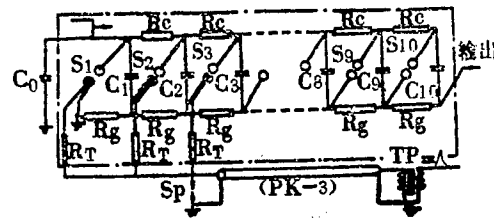
C_1-C_{10}, capacitors (MY100-0.12); S_1-S_{10}, spherical discharge
switches; R_c, charging resistor (30 kohm): R_g, charging
ground resistor (12 kohm); R_T, voltage dividing resistor for
triggering switch (1.5 kohm); S_p, protective gap; PT, pulse
transformer (1:1); PK-3, triggering signal cable; dotted-dashed
line shows outline of oil box.

Figure 2. General View of Generator
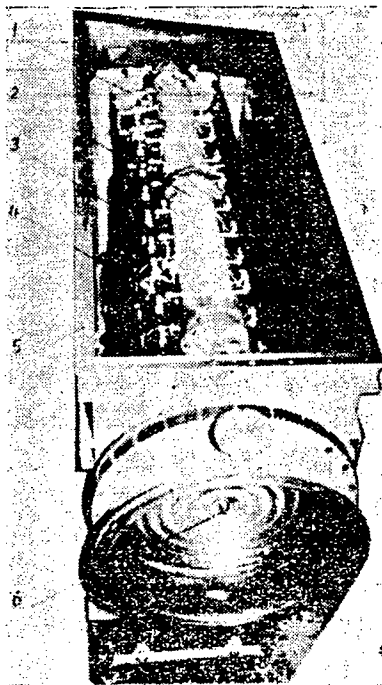
Key:
1. Triggering resistor
2. Gas intake switch
3. Charging ground resistor
4. Capacitors
5. Oil box
6. High-voltage pulse output
   terminal

As the foreging indicates, the Marx generator is compact and easy to hook up, with low inductance and small dimensions: its external measurements are 2 m long by 0.78 m wide by 1.3 m high.

2. Discharge Switches and Triggering System

The discharge switch is one of the key components of the Marx generator. In our generator the discharge switch system uses a polypropylene tube 160 mm in diameter and 1,550 mm long with a wall thickness of 8 mm, with 10 pairs of discharge spheres sealed inside with equal spacing. The tube is filled with dry nitrogen at a pressue which can be adjusted between 1 and 6 atmospheres. Thus it is called a "straight-tube gas-filled discharge switch." Figure 3 shows its layout. The electrodes are made of 1Cr18Ni9Ti stainless steel, with a gap of 15 mm between them. Once installed they are not further adjusted. If a different output voltage is required, the change is made by adjusting the gas pressure.

Figure 3. Straight-tube gas-filled discharge switch
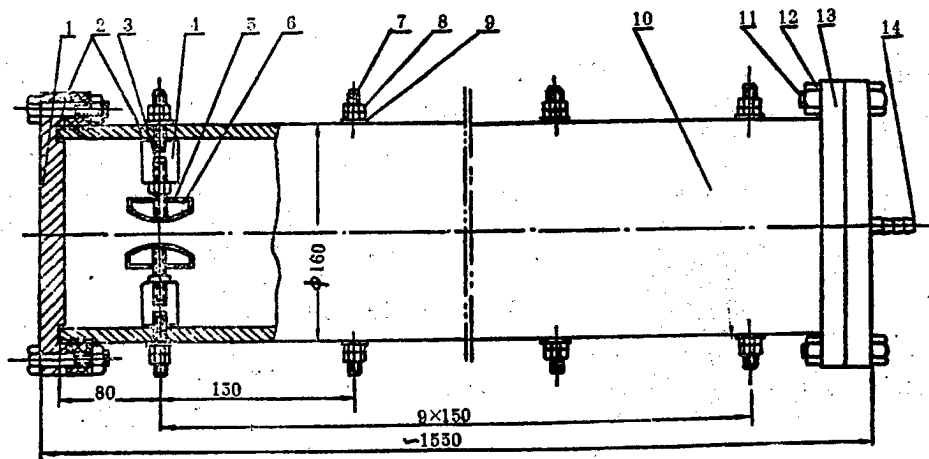
Key:
1. End plate
2. Rubber gasket
3. Interior bolt
4. Intermediator pressure gasket
5. Flat plate
6. Discharge poles
7. External bolts
8. Not (M8)
9. Round washer
10. Polypropylene tube
11. Bolt (M10)
12. Nut (M10)
13. Flange
14. Gas inlet connector

The operating stability of a Marx generator depends primarily on the stability of its discharge switch operation. First, because all pairs of discharge poles are within the same container, the breakdown discharge at the first gaps may produce light effects on the succeeding gaps, which helps them to discharge and helps stabilize the operating time. In addition, since a three-stage trigger system is used (see figure 1), a 12-kV trigger pulses is applied simultaneously to the first three switches, as a result the switches

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operate at 70 percent of the spontaneous-discharge breakdown voltage. When the working conditions (gas pressure, gas replacement frequency, rest time) are strictly controlled, the variability in the time control can be kept below 0.1 μs and the probability of loss of control is less than 1 percent.

3. Technical Characteristics

A relatively long period of operation of the Marx generator has shown that it has excellent characteristics. The main technical characteristics are given in Table 1.

Table 1. Main characteristics of compact 1 MV Marx generator

Number of stages	10
Capacitance of each stage	0.12 μF
Rated DC charging voltage	100 kV
Impact capacitance	12 nF
Impact inductance	~ 6 μH
Nominal output pulse voltage	1 MV
Nominal energy storage	6 kJ
Energy storage density	3 kJ/m^3
Voltage output efficiency	85 percent
Generator operating time	0.4 μs
Pulse voltage rise time	0.6 μs
Time control variation	< ±0.1 us

Figure 4 shows the voltage waveform for charging of a Blumlein line by the Marx generator. The capacitance of the Blumlein line was 12 nF, the wave impedance was 8 ohms, and the charging time was about 0.6 μs. The generator's voltage output efficiency was 85 percent.

Figure 4. Waveform of charging of Blumlein line
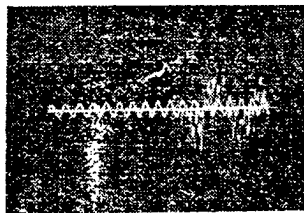
The work described here was guided by Comrade Tao Zucong [7118 4371 5115]; participants inclued Li Yannian, Dai Guangsen, Cao Guogao, Xie Hengjia, Ding Baoxian, and Liu Damin.

^{10}B BURNUP DETERMINATION IN BORON STAINLESS STEEL TUBE OF DISCHARGED REACTOR FUEL USING MASS SPECTROMETER

[Article by Zhang Chunhua [1728 2504 5478], Xu Huaizhong [6079 2037 1813], Liao Zumin [1675 4371 3046], et al: "Mass Spectrometric Determination of ^{10}B Burnup in Boron Stainless Steel Tube of Discharged Reactor Fuel"]

[Text] Abstract

A methanol distillation method was introduced in this paper to separate the boron in a boron stainless steel tube of discharged reactor fuel from the fission product ^{60}Co and other elements. The burnup of combustible poison ^{10}B in the boron stainless steel tube was measured by the thermionic surface ionization method in a CH$_5$ mass spectrometer. When the burnup level is higher than 80 percent, the relative standard deviation is less than 0.1 percent.

I. Introduction

Because the absorption cross-section of the thermal neutron of ^{10}B is large (approximately 4,000 barns), therefore, it is used as a combustible poison to absorb neutrons in a reactor. Almost all the pressurized water reactors in power plants use combustible poison elements made of boron based materials. The burnup distribution of the reactor can be understood, the accuracy of the physical design of the reactor can be evaluated, and the operating safety and reliability can be improved by measuring the variation of ^{10}B before and after the irradiation.[1]

Boron can be separated by using the methanol distillation method or ion exchange method. [2,3] The methanol distillation method is a classical method to separate boron. A great deal of work has been done by predecessors. [4,6]

We have used this method to separate a small amount of boron from high purity aluminum which was the casing material of the element, [7] from aluminum-lithium alloy which was the target material, and unexposed boron stainless steel tube with satisfactory results. This paper described the separation of boron from the fission product ^{60}Co as well as seven stable elements such as iron, chromium, nickel, silicon, manganese, carbon and sulfur by using the methanol distillation method. A mass spectrometric method was used to

determine the isotope ratio of boron in order to further determine the relative burnup percentage of boron in the discharged boron stainless steel tube of the reactor.

II. The Experiment

1. Sampling

Sampling points were selected based on the design requirements by taking into account that the average axial burnup was to be measured. The results of isotope dilution mass spectrometric measurements showed that the distribution of boron in the boron stainless steel tube was inhomogeneous before irradiation either radially or axially. In order to eliminate the effect of radial inhomogenity on measuring burnup, a saw was used to cut off a ring from the boron stainless steel tube. The fine powder of the specimen in a quadrant (approximately 0.5-1.0g) was collected and placed in a plastic sample container by a mechanical arm for future use.

2. Separation

(1) Purification of Reagents 1) Purification of Methanol: Methanol was placed in a clean quartz distiller with several soidum hydroxide (ultrapure) pellets added. It was distilled in a water bath at 75° - 80°C. The first 20-30ml of the initial distillate was discarded. The middle distillate was collected and contained in a clean plastic bottle. When there was about 50ml of liquid left in the distiller, the operation was terminated. The middle distillate was re-distilled. The middle distillate of the second distillation was used as the product. It was sealed in a clean, dry plastic bottle for further use.

2) Purification of Sulfuric Acid. Sulfuric acid (ultrapure) was placed in a platinum container. A small amount of hydrofluoric acid was added. It was heated to evaporate until the sulfuric acid fumed for over half an hour. After cooling down, it was placed in a quartz bottle for further use. The concentration of sulfuric acid used in this experiment was 1:1, which was made by diluting the purified sulfuric acid with triply distilled water by one fold.

3) Purification of Water. Tap water treated with ion exchange columns was placed in a clean quartz distiller which was capable of performing double distillation. It was boiled over an electric furnace to obtain doubly distilled water. The doubly distilled water was placed in a clean quartz distiller with several drops of 2N sodium hydroxide and phenophthalein added. The solution appeared to be pink. It was boiled on an electric stove for distillation. The initial distillate was discarded. The middle distillage was collected in a plastic bottle as the product.

4) Sodium Hydroxide (1 percent): Sodium Hydroxide (ultrapure) and triply distilled water were used to prepare a 1 percent solution which was stored in a quartz bottle.

5) Glycerol (10 percent): Glycerol (analytically pure) and triply distilled water were used to prepare a 10 percent aquous glycerol solution to be stored in a quartz bottle.

(2) Separation Apparatus. The separation apparatus included a home-made quartz distiller and a home-made thermostated constant termperature water bath (see Figure 1). This set of apparatus was placed in a stainless steel hood. It was simple and practical. The recovery rate was above 80 percent, suitable for radioactive operations.

Figure 1. Schematic Diagram of the Separation Apparatus
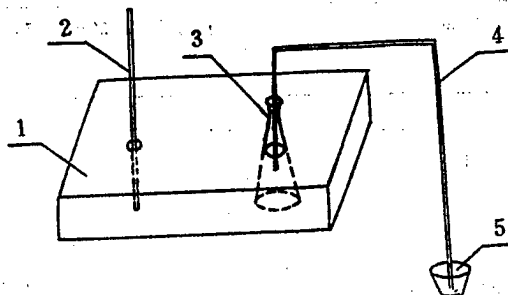
Key:
1. constant temperature water bath tank
2. contact thermometer
3. ground joint quartz distiller
4. plastic tube
5. quartz crucible

(3) Sample dissolution. The boron steel specimen cut in a hot room was shipped to a stainless steel hood in the laboratory. β and γ detectors were used to measure the dose strength of the specimen. The specimen in the plastic container was shaken several times to allow mixing. Approximately 120mg of boron steel specimen was taken from it and placed in a quartz beaker. It was washed three times with ether and baked dry by an infrared light; 72ml of 1:1 sulfuric acid was then added to completely dissolve it. The solution was equally divided into six parts to proceed with methanol distillation.

(4) Distillation Separation. All six test solutions were transfered into distillers; 24ml of methanol was added into each distiller. It was mixed well and then placed in the water bath to be distilled at below 90°C. The distillate-trimethyl boride-was collected in a quartz crucible containing 6ml of triply distilled water, two drops of 1 percent sodium hydroxide and 50μl of 10 percent glycerol.

In the methanol separation process, the following chemical reactions took place:

$$3CH_3OH + H_2BO_3 \Longrightarrow (CH_3O)_3B + 3H_2O$$
$$(CH_3O)_3B + 3H_2O \Longrightarrow H_3BO_3 + 3CH_3OH$$
$$4H_3BO_3 + 2NaOH \Longrightarrow Na_2B_4O_7 + 7H_2O$$

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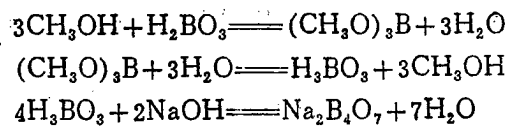
Table 1. Burnup Values of ^{10}B at Various Positions

Sample No. Burnup Item	1	2	3	4	5	6
Sampling sequence						
1	83.79	94.75	95.84	39.73	56.05	79.34
2	83.82	94.66	95.81	40.92	56.40	79.28
3	83.72	94.77	95.83	39.65	55.98	79.35
4	83.79	94.67	95.83	39.73	56.72	79.35
5	83.90	94.67	95.82	39.77	55.96	79.27
6	83.80	94.66	95.83	39.97	55.84	79.34
Average Percent	83.81	94.70	95.83	39.96	56.16	79.32
Standard deviation	0.06	0.05	0.01	0.24	0.14	0.04
Burnup	$(83.81^{+}_{-}0.10)$ percent	$(94.70^{+}_{-}0.08)$ percent	$(95.83^{+}_{-}0.02)$ percent	$(36.96^{+}_{-}0.40)$ percent	$(56.16^{+}_{-}0.2)$ percent	$(79.32^{+}_{-}0.07)$ percent
Remark	reliability 99 percent					

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^{60}Co and seven other stable elements could not be distilled in the distillation separation process and remained in the distiller as an organic medium level radioactive waste liquid to be stored in a prepared container.

The distiller and other utensiles were decontaminated and washed rigorously. Detectors were used to monitor the decontamination of these utensiles after they were dried. Further decontamination might be required when the requirements were not met.

(3) Mass Spectrometric Determination.

The chemical status of the specimen had to be boraz ($Na_2B_4O_7$) for mass spectrometric determination. The trimethyl boride in the distillate was converted into borax in the sodium hydroxide receiving solution. A crucible containing this receiving solution was evaporated dry over a 90°C water bath. Before undergoing the mass spectrometric analysis, a small amount of triply distilled water was added to the crucible. It was then coated on a rhenium belt. We used a Varian MAT CH$_5$ mass spectrometer, a therminonic surface ionization source and a simple Faradaic receiver. The receiving ion was $Na_2BO_2^+$. More than two spectra (each with 10 pairs of peaks) were taken for each specimen to calculate the abundance ratio of isotopes M/e = 88 and 89. After subtracting the contribution of ^{17}O, it could be converted into the isotope abundance ratio $R_{10/11}$ of ^{10}B to ^{11}B.

Mass spectrometric analysis was carried out for a series of irradiated specimens. The results of six specimens are listed in Table 1.

III. Discussion

It is theoretically believed that the data obtained by using isotope dilution mass spectrometry is more accurate. However, the ^{10}B content before irradiation must be known. The isotope dilution method was not used in this work because the ^{10}B contents at corresponding points prior to irradiation were not known. Furthermore, the amount of natural boron per unit volume radially and axially varies greatly (weight content ranges from 0.4-0.6 percent). Therefore, only the isotope ratio method could be used to measure the burnup. Moreover, according to a theoretical calculation, the burnup of ^{10}B is relatively high. It is more favorable to use the isotope ratio method. Based on Reference 1, the accuracy of the measurement can reach 0.2 percent when the ^{10}B burnup is over 80 percent.

The following formula was used to calculate burnup in this work

$$\overline{Bu} = (1 - R_1/R_0) \times 100$$

where $\overline{Bu}$ is the average burnup percent; R_0 is the natural isotope ratio of ^{10}B to ^{11}B after irradiation.

Experimental results showed that the relative standard deviation of the measured values was less than 0.1 percent when the burnup was over 80 percent. When the burnup was in the 50-80 percent range, the relative standard deviation was 0.7-0.1 percent. When the burnup was less than 50 percent, the relative standard deviation was greater than 1 percent.

This method has the following advantages: 1) very small sample and weighing not required; 2) quantitative separation not required and accuracy depending on measuring the isotope ratio, unrelated to recovery ratio; 3) error in dissolved specimen not to be considered; 4) only boron distilled from methanol and other impurities remained in distillation flask.

In addition, the structure of the separation apparatus used was simpler than the ones described in the literature [5,6]. It was easy to operate and handle, suited for a highly radioactive hood. Furthermore, after using a piece of 2cm thick movable lead glass as a shield, γ intensity could be reduced to 70 percent of the original level. The drawback of the method is that methanol is poisonous.

2. Contamination Problem.

Boron is a common element, which is susceptible to contamination. Contamination due to the environment, utensiles and reagents will directly affect the accuracy of measurements. Therefore, reagents must be purified strictly. Utensiles will have to be made of quartz and polyethylene which did not contain any boron. Contamination among the specimens must be prevented when the boron steel tube is cut. Good ventiliation must be maintained in the operating environment. Everything has to be clean. A blank must be burnt for the rhenium bands used in the mass spectrometer. Used bands must be discarded. Used components and quartz containers must be thoroughly decontaminated before using them again. In order to detect boron contamination from the external world, two methods were used to measure the total boron blanks in the reagents as well as the operating process for comparison. The total blanks for four simulated specimens measured by the isotope dilution mass spectrometric method are shown in Table 2. The results of total blanks of eight simulated specimens measured by the turmeric colorimetric method are shown in Table 3.

Table 2. Total Boron Blank Measured by Isotope Dilution Mass Spectrometry

Number	1	2	3	4
R10/11 (mixture)	15.836	14.657	16.447	16.570
boron content, g	-3.3×10^{-7}	8.8×10^{-7}	1.2×10^{-7}	5.4×10^{-8}

Table 3. Total Boron Blank Measured by Turmeric Colorimetry

Number	1	2	3	4	5	6	7	8
absorbance	0.110	0.150	0.090	0.115	0.045	0.070	0.070	0.100
boron content g	4×10^{-7}	5.7×10^{-7}	3.6×10^{-7}	4.0×10^{-7}	1.8×10^{-7}	2.7×10^{-7}	2.7×10^{-7}	4.1×10^{-7}

From tables 1 and 2 one can see that the total blanks measured by both methods are above 10^{-7}g. In other words, the effect of the total blank on a specimen containing approximately 120 μg of boron is only several parts per thousand. If a certain specimen shows a significant drop of the isotope ratio in six parallel samples, exceeding the range of total blank effect, then it is believed to be contaiminated by natural boron and should be discarded.

3. Alkalinization. The chemical state of the specimen must be sodium tetraborate for mass spectrometric analysis. The ion to be detected is $Na_2BO_2^+$. Therefore, an appropriate amount of sodium hydroxide must be added to the receiving solution to convert to the state required for analysis. However, over alkalinization will form sodium metaborate, affecting the emission and stability of the ionic stream in mass spectrometric analysis.

Consequently, the accuracy of the measurement is affected. Some literature[2] reported that the pH of the receiving solution should be controlled at 8-9. Our experience was to add a suitable amount of glycerol with slightly excessive amount of base. It is not only capable of improving the receiving efficiency but also provides specimens suitable for mass spectrometric analysis without fine tuning the pH.

This work was guided by Comrade Zhang Shougang [1728 1343 4854] and comrades Zhang Xianqing [1728 6897 3237], Zhong Yujing [6988 3254 0079] and Xie Yonghuai [6200 3057 3232] were also involved in some parts of the work. The authors wish to express their gratitude.

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RESEARCH ON NITROGEN/OXYGEN SATURATION DIVING, DECOMPRESSION

[Article by Chen Baosong [7115 1405 2646], Institute of Oceanographic Underwater Engineering, Ministry of Petroleum Industry and Ministry of Communications*]

[Text] Saturation diving is a new technology which has been swiftly developed during the past 20 years. Since nitrogen is inexpensive and readily available, the combination of nitrogen/oxygen saturation with air circulation diving technology can meet the large-scale material needs for diving undertakings in the coastal waters (within 75 meters from the coast). The economic value of saturation diving is considerable.

A key problem in underwater physiology is decompression after a long period of exposure under a high barometric pressure. There has been a satisfactory plan[1] for decomposition for nitrogen/oxygen saturation within 30.5 meters of seawater depth. But for the decompression of nitrogen/oxygen saturation between 30.5 meters and 36.5 meters, there has not been a complete report. Between 1977 and 1979, several concerned units in China cooperated to conduct nine groups of tests on underwater nitrogen/oxygen saturation to study systematically the regular medical and physiological changes in human bodies exposed to nitrogen/oxygen saturation[2-4] and problems concerning air circulation diving and saturation decompression plans, etc. In this article, we will discuss the decompression problem of nitrogen/oxygen saturation diving.

I. Subjects under Test and the Testing Method

There are altogether 9 groups of tests, involving 39 subjects with a total of 54 person-time saturation diving in nitrogen/oxygen saturation. The age of the 33 professional divers ranged from 18 to 32 with a length of service ranging from 2 to 16 years. The other six participants were researchers in underwater medical science and physiology whose ages ranged from 28 to 36. Researchers did not participate in air circulation diving during the tests.

The conditions designed for the nine groups of tests were identical: oxygen partial pressure was 0.30 ± 0.05 bar; carbon dioxide partial pressure was less than 5 millibar; the temperature of the environment was 26 ± 1° C; and the relative humidity was 60 ± 10 percent. The first eight groups of tests proceeded in the simulated cabin for saturation diving and the cabin for air circulation diving. The ninth group of tests took place in the Yingge Hai area of the Nan Hai using a diving bell--a system of deck pressurization, cabin saturation diving equipment which was attached to a half-submerged drilling platform, Nanhaierhao [Southern Sea No 2]. The actual air circulation diving depth was 64 meters.

The decompression of saturation diving was conducted 24 hours after the conclusion of the last air circulation dive. The salient features of the nine groups of tests in decompression are summarized in Table 1. The decompression process is shown in Figure 1.

Tests 1-5 and Test 9 employed a 1.5-meter interval of depth for stage decompression. Major parameters adopted were: The theoretical tissue half-saturation for nitrogen was 1,200 minutes; the largest permissible surface oversaturation value was 4.5 meters; the oversaturation δ value of nitrogen was an increase of 1 meter for each 1-meter increase in water depth;[1] starting from 10.5 meters, the subjects under tests breathed pure oxygen at intervals and breathed cabin air while eating or sleeping. The time for not breathing oxygen was twice the duration for oxygen breathing. The plan adopted for Test 6 was based on the plan for Test 5. A 3-hour stop was observed for the first four stages by extrapolation. The other tests proceeded according to the plan for Test 5.

Tests 7 and 8 used self-proposed speeds to decompress at equal speed using the DZK-1 model electronic pressure control equipment trial-manufactured by the Navy Institute of Medicine. For Test 7, the oxygen partial pressure used for decompression in water deeper than 18 meters was 0.6 bar. For Test 8, the oxygen partial pressure used for decompression in water deeper than 15 meters was 0.5 bar. Later, regular air was filled in the cabin. Intermittent breathing-in of oxygen was arranged when in water whose depth was less than 11 meters.

Table 1: Decompression Tests in Nitrogen/oxygen Saturation Diving

Test seq. no.	Test date	Satura- tion (meters)	No. sub- ject	Days	Dec. time (h=min)	Oxy. time (h=min)	Dec. Method	Dec sick	Max Δ P_{1200} (meter)
1	1977.11.23--12.4	20.0	6	10	43:31	6:26	stage	0	< 4.5
2	1977.12.19--12.29	30.5	6	7	70:45	7:30	stage	0	< 4.5
3	1978. 5. 2-- 5.13	30.5	7	8	72:38	7:00	stage	0	< 4.5
4	1978. 6. 1-- 6.12	30.5	7	9	70:50	7:00	stage	0	< 4.5
5	1978. 7.13-- 7.23	30.5	3	6	67:13	6:40	stage	0	< 4.5
6	1978. 8. 5-- 8.18	36.5	7	9	79:03	9:33	stage	0	5.28
7	1979. 5.17-- 6.16	36.5	7	26	95:54	10:25	eq sp	0	6.09
8	1979. 6.30-- 7.11	50.0	6	5	171:30	12:30	eq sp	1	7.05
9	1979.12. 3--12.13	36.5	5	6.5	89:47	10:47	stage	0	4.68
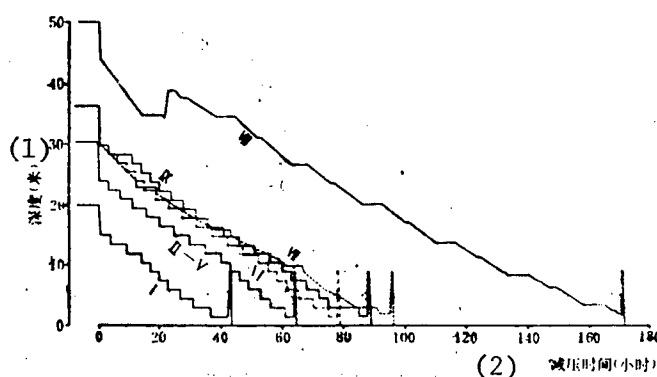
Figure 1: Procedure of Decompression for Nine Groups of Nitrogen/oxygen Saturation Diving

KEY: (1) Depth (meters)
(2) Decompression time (hours)

The analysis and the computation of the decompression parameters were conducted using a domestically produced DJS-130 model digital electronic computer.

II. Results

Of the 9 groups of the 54-person oxygen saturation decompression, only 1 incident of mild decompression sickness was observed during the 8th group of tests at a depth of 50 meters.

During the eighth group of decompression tests, the oxygen partial pressure of the cabin was kept at 0.5 bar. We started by reducing the pressure from 50 meters to 44 meters in 10 minutes and proceeded to decompress with equal speeds at 90 minutes per meter. On that day we conducted decompression continuously for 14 hours and the pressure of the cabin was approaching 35

meters. One of the divers (age 32, with a service age of 15) experienced pain in his left shoulder joint at this time. The diver did not pay much attention to the pain, as his shoulder had always been uncomfortable after exposure to coldness. During the sleeping period at 35 meters, the pain became more intense. The joint was sore with a paroxysmal needling sensation. He endured the pain until the following morning to start treatment with pressure. The cabin pressure was gradually increased from 34.5 meters to 39 meters in 49 minutes. The symptom disappeared completely. The diver was confirmed as having had decompression sickness. The diver stayed in the depth for 1 hour and 14 minutes, during which time he breathed in regular air through a mask for 1 hour. Thereafter, the pressure was reduced to 35 meters at the speed of 180 minutes per meter. There was a one night of rest at 35 meters. Between 35 meters and 28 meters, the speed was 120 minutes per meter. From 28 meters to 15 meters, the speed was 150 minutes per meter. From 15 meters to 10 meters, the speed increased to 180 minutes per meter. Intermittent oxygen breathing was practiced when the water reached a depth shallower than 10 meters. Total time used (including the time used for pressure treatment) was 171.5 hours. All of the participants left the cabin safe and sound after decompression. The diver who was sick was observed continuously for 2 weeks. There was no recurrence of discomfort in his left shoulder joint.

Using an electric computer, we analyzed and computed the decompression process parameters of each test and constructed the graph between submergence depth and saturation tension value ΔP_{1200} formed in tissues for nitrogen in 1,200 minutes. The result is shown in Figure 2.
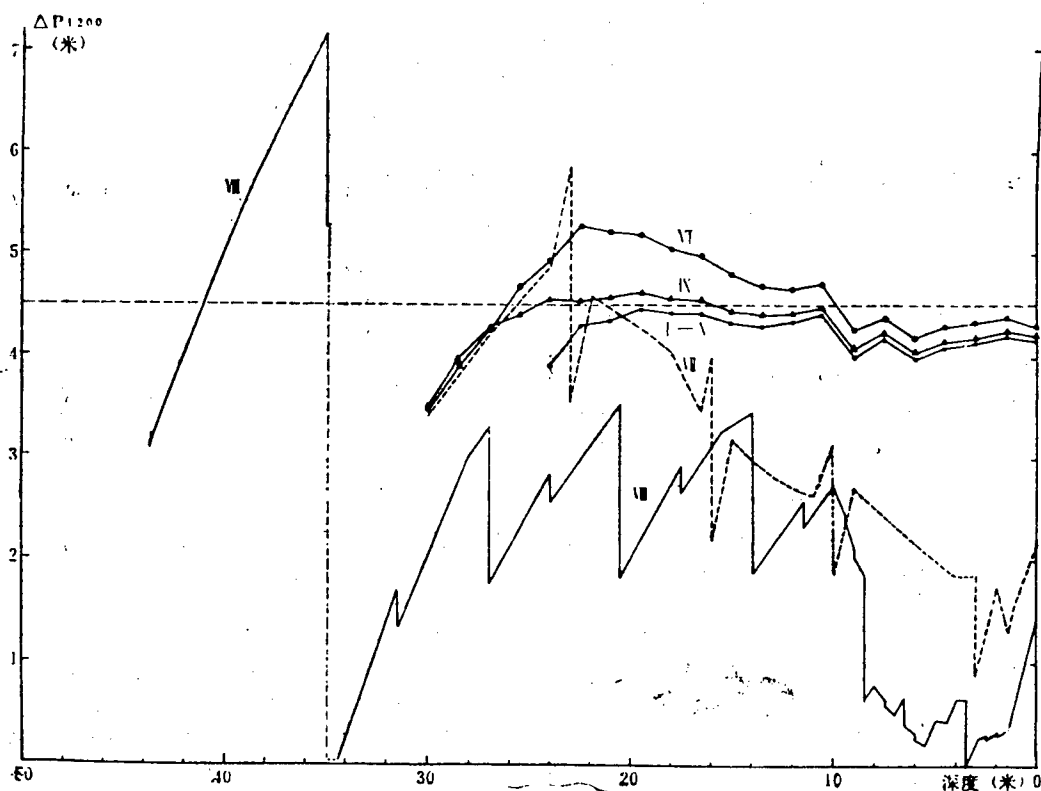

17

Figure 2: The Oversaturation Tension of Tissue, Formed in 1,200 Minutes
in Different Depths for Nine Groups of Nitrogen/oxygen Saturation
Decompression Process

Figure 2 shows that Tests 1-5 basically adopted the NOAA plan with the largest
nitrogen oversaturation tension not exceeding 4.5 meters but close to 4.5
meters, thus allowing neutral gases to maintain maximal and safe desaturation
gradients.

For Test 6, there were 3-hour stops at the 28.5-meter, 27-meter, 25.5-meter
and 24-meter stages, respectively. The 3-hour duration was not long enough
to shed off the 1.5-meter nitrogen tension formed in 1,200-minute tissues, thus
causing the ΔP_{1200} value to increase. At the 28.5 meter to 12 meter depth,
ΔP_{1200} values were all slightly higher than the 4.5-meter oversaturation
value as regulated, the largest amount being 5.28 meters. The seven subjects
being tested did not have decompression sickness, and the time used for
decompression was 79 hours.

Table 2: Decompression Table for Nitrogen/oxygen Saturation Diving

Saturation depth (meters)	First Stopping Stage			Subsequent Stopping Stages		
	Depth (meters)	Gas	Stopping time (hour:min)	Depth (meters)	Gas	Stopping time (hour:min)
36.5	30	nitrogen	3:00	28.5	nitrogen	3:00
35	28.5	nitrogen	3:00	27	air	3:00
33.5	27	air	3:00	25.5	air	3:30
32	25.5	air	3:00	24	air	4:00
30.5	24	air	3:00	22.5	air	4:00
28.5	22.5	air	3:00	21	air	4:00
27	21	air	3:00	19.5	air	4:30
25.5	19.5	air	3:00	18	air	4:30
24	18	air	3:00	16.5	air	5:00
22.5	16.5	air	3:30	15	air	5:00
21	15	air	3:30	13.5	air	5:00
19.5	13.5	air	3:30	12	air	5:00
18	12	air	4:00	10.5	air	0.30
				10.5	oxygen	1:00
16.5	10.5	oxygen	1:00	10.5	air	0:30
				10.5	oxygen	1:00
				9	air	2:00
15	9	air	2:00	9	oxygen	1:00
				7.5	air	0:30
				7.5	oxygen	1:00
13.5	7.5	oxygen	0:30	7.5	air	0:30
				7.5	oxygen	1:00
				6	air	3:00
12	6	air	1:30	6	oxygen	1:00
				4.5	air	0:30
				4.5	oxygen	1:00

10.5	4.5	oxygen	1:00	4.5	air	0:30
				4.5	oxygen	1:00
				3	air	4:00
9	3	air	2:00	3	oxygen	1:00
				1.5	air	0:30
				1.5	oxygen	1:00
				1.5	air	0:30
7.5	1.5	oxygen	0:30	1.5	oxygen	1:00
				9	oxygen	0:30
6.5	no de-compres-sion			out of water		

Test 7 adopted equal-speed decompression. After an initial decompression of 6.5 meters from 36.5 meters, the pressure was reduced from 30 meters to 24 meters at a speed of 120 minutes per meter. The computation results showed that the ΔP_{1200} value had increased to 5.09 meters. Thereafter, the decompression was 1 meter for every 10 minutes, with stages of sleeping stops, to raise the ΔP_{1200} value to 6.09 meters. From the angle of decompression theory, we see that the stages were dispensable. After 6 hours of sleeping, a fast-speed decompression of 1 meter was conducted to reraise the ΔP_{1200} value, being careful not to exceed the regulated value of 4.5 meters. The following speed at 180 minutes per meter was a suitable and stable speed. But the speed of 240 minutes per meter used for within the 18-meter depth was rather slow, which lengthened the total decompression period to 96 hours.

In Test 8, after a fast-speed decompression of 6 meters, a 90 minutes per meter decompression followed, which caused the ΔP_{1200} to rise in a straight line. The computation result showed that at 35 meters, the ΔP_{1200} value had reached 7.05 meters. During this time a case of mild decompression sickness occurred. Although individual physical factors were involved, the high ΔP_{1200} value should be regarded as one of the hazardous factors.

While the testing ground for the ninth group of tests proceeded in the sea, the stage decompression plan was adopted based on actual conditions and considerations of divers' fatigue caused by repeated diving endeavors which consumed body energy. During decompression, the ΔP_{1200} variation was kept at the vicinity of 4.5 meters. The desaturation speed was relatively large. The maximum nitrogen oversaturation tension value was 4.68 meters. The total period of actual decompression was 90 hours.

Based on the 9 groups of tests with a total of 54 person-time experiments, particularly based on the results from Tests 6 and 9, we tentatively constructed a 36.5-meter stage decompression plan as shown in Table 2. The maximal value of ΔP_{1200} was computed at 4.63 meters and the total decompression time was 78 hours and 30 minutes.

III. Discussion

The computation used in the saturation diving decompression plan was based on the concept of Haldane concerning the regularity of the movement of neutral gases in the human body.[5] There was a close relationship between the desaturation of neutral gases in human bodies and the blood circulation in body tissues. The desaturation process can be described as: for any given half-saturated tissue, the speed the neutral gas was released and the tension value of that gas in the tissue are directly proportional to the gradient difference of the partial pressure value of the gas and the environment gas. The following equation describes the process in which π is the tension of the nitrogen dissolved in the tissue and P_{N2} is the nitrogen partial pressure in the environment gas. The nitrogen desaturation speed of the tissue is:

$$\frac{d\pi}{d_t} = -k\ (\pi - P_{N2}) \tag{1}$$

where k is the constant related to the half saturation time for the tissue. If the half saturation time for the tissue is $t_{1/2}$, then

$$k = \frac{\ln 2}{t_{1/2}} = \frac{0.693}{t_{1/2}} . \tag{2}$$

During saturation diving, since all tissues in the body are in a saturated state, we should use the slowest desaturation speed in the half-saturated tissue of the body to control the decompression process.[6] Taking into consideration the nitrogen/oxygen saturation diving experience in other countries, we conclude that the slowest nitrogen half-saturation in tissue takes 670 minutes.[7] Considering the variations in age and physical condition of the scientific research personnel, and the possibility of the rise of special situations to ensure safety, the 1,200 minutes we adopted for half saturation time is still suitable.

To compute the value of safety for tissue oversaturation in saturation diving, we found that the M value concept of Workman[8] comes in handy. For certain half-saturated tissue, its permissible neutral gas oversaturation tension is the linear function of the depth it is in. For a half-saturated tissue of 670-1,200 minutes, its permissible nitrogen oversaturation tension increases at the same amount as the amount of increase in depth, namely, the oversaturation δ value is the permissible oversaturation of 1 meter of water column increase at each 1-meter increase in water depth[9], which can be expressed by the following equation:

$$\pi_M = H + \Delta P \tag{3}$$

in which π_M is the maximum permissible oversaturation tension of the tissue under certain depth, H is the total absolute pressure at the external boundary of the depth and ΔP is the difference of the safe nitrogen oversaturation tension, i.e., the M value of Workman. For a 670-1,200-minute tissue, we choose ΔP at the 4.5-meter water column. For the saturation environment of the nitrogen/oxygen mixture, the oxygen partial pressure is

$$P_{O2} = H - P_{N2} \qquad (4)$$

Substituting Formulas (2), (3) and (4) for Formula (1), we arrive at (5):

$$\frac{dt}{d\pi} = \frac{-t \, \frac{1}{2}}{0.693 \, (\Delta P + P_{O2})} \qquad (5)$$

where we see that the desaturation speed of a tissue $\frac{dt}{d\pi}$ is closely related to the oxygen partial pressure of the air breathed in. The computation of the value of ΔP for $t_{1/2}$ = 1,200 minutes tissues can be used as a gauge for evaluating a certain decompression plan. For a decompression process under a certain oxygen partial pressure P_{O2} to decompress at a certain speed $\frac{dP}{dt}$, the nitrogen oversaturation tension $\Delta P_{1,200}$ of the 1,200 minutes tissue under various underwater depths can be computed in Formula (5) as shown in Figure 2. ΔP can be one of the theoretical parameters for safe decompression.

With regard to decompression method, our group of tests employed the stage decompression method and the equal-speed decompression method independently. In an actual worksite, under the premise of being in a situation of not having a complicated automatic control system for regulating cabin pressure, the stage decompression method with 1.5-meter depth intervals is easier and can maintain a constant permissible oversaturation tension value and a reasonable total decompression time. The 36.5-meter nitrogen/oxygen saturation diving decompression table as suggested by this article was constructed based on repeated laboratory and worksite tests and explorations and should be safe and reliable. If it can be confirmed in practical use, it can be adopted for worksite nitrogen/oxygen saturation use.

Theoretically, the equal-speed decompression method has the merit of maximizing the speed of expelling the neutral gases from tissues. Based on an analysis of the ΔP_{1200} curve under different depths, to make the one-time equal-speed decomression safe and fast, the decompression speed must be in agreement with the desaturation law of neutral gases. First of all, we must select the proper extent for primary decompression. If the extent is too large, the oversaturation tension value of the tissue rises, thus running the risk of decompression sickness. If the extent chosen is too small, the oversaturation tension value of the tissue will not have the greater gradient proponderance and thus become detrimental to the desaturation of the tissue.

As a result, not only the total decompression time is lengthened, but subsequent decompressions will be adversely affected also. Our next problem is to select a suitable intermediate decompression speed. To raise the oxygen partial pressure of the breathed-in air within the permissible range is advantageous to decompression. We can select the corresponding decompression speed according to the oxygen partial pressure value of the breathed-in air at different depths. Within the 30-11 meter depth we use ordinary air for decompression and the decompression speed ranges from 140 to 190 minutes per meter. We can roughly distinguish the decompression speed by the following: from 30-18-meter depth, we use a speed of 150 minutes per meter; from the 18-11 meter depth, we use a speed of 180 minutes per meter; and at a depth of 11 meters or less we arrange for intermittent oxygen breathing and select the appropriate decompression speed. We must pay special attention to the three links in order to achieve the objective of safe and fast decompression.

IV. Conclusion

In this article we have reported the results from the nine groups of nitrogen/oxygen saturation diving decompression at depths from 20 meters to 50 meters. A total of 39 healthy male subjects have undergone 54 person-time saturation decompression under identical testing conditions, and different decompression parameters were adopted.

The decompression plan for each group of tests computes the nitrogen over-saturation tension value ΔP_{1200} of the 1,200-minute tissue at varying depths. It was observed that in Test 8, when the 50 meters were being reduced to 35 meters, the value of ΔP_{1200} reached its maximum--7.05 meters. At the same time, one of the six subjects being tested had a case of mild decompression sickness. For the other eight groups of decompression tests, the largest ΔP_{1200} value was 6.09 meters (at 22 meters depth). Of the 8 groups of tests, there were 3 groups with 19-person-time 36.5-meter saturation decompression. The subjects all left the cabin in good health. The result of the analysis showed that the computed ΔP_{1200} value could be used as an important indicator for safe decompression. Based on the above tests, a 36.5-meter nitrogen/oxygen saturation and stage decompression plan was constructed. The largest ΔP_{1200} value was 4.63 meters (at the 19.5-meter stop). Total decompression time was 78 hours and 30 minutes. The plan is easy to implement and can be used in real worksite situations after it is tested in practice.

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PLASTIC SURGEONS ADVANCE IN ONE-STAGE OPERATIONS

OW080700 Beijing XINHUA in English 0630 GMT 8 Jun 84

[Text] Beijing, 8 June (XINHUA)--Chinese plastic surgeons can now reconstruct entire noses, ears, breasts and penises in one-stage operations instead of traditional multiple-stage operations.

These organs, reconstructed in a one-stage operation, are similar in form and function to those reconstructed by traditional methods, and are even better in some aspects, such as the sensory function, according to Professor Song Ruyao, director of the plastic surgery hospital of the Chinese Academy of Medical Sciences in Beijing, and president of the Chinese plastic surgery society.

The leading plastic surgeon pointed out that rapid advances have been made since China began to develop its expertise in this kind of surgery in the early 1950's. The Chinese plastic surgery society was admitted as a member of the international plastic surgery society last year.

Reconstruction of the entire nose, repair of the facial and buccal (the cheeks) defects and bone grafts for large mandibular defect are now up to advanced world standards, the professor added. The success rate for skin grafting in early and late burn cases is high, he noted.

Chinese surgeons have also improved on many classical operations. For example: direct transplantation of the frontal muscle flap has been used in treating congenital ptosis of the eyelid; the triangular flap from the base of the nose has been transferred for repairing harelips; and new methods of treating cleft palates have been pioneered.

Initial results have been obtained in integrating traditional Chinese medicine with plastic surgery. And surgeons have made successful trials of "heat and bandage therapy" to treat elephantiasis (a skin disease, causing gross enlargement of limbs).

Progress has also been made in materials for tissue transplants. Plastic surgeons have found that bovine nasal septal cartilage is an ideal material for use in ear and nose reconstructions. The septal cartilage, which can be taken from cattle of any age, is large and of good quality (no tendency to curve and easy to store). Previously, surgeons had used bovine costal cartilage which is only obtainable from calves.

In the field of microsurgery, Professor Song said, development has been rapid over the past 15 years. All kinds of free skin flaps and muscle skin flaps which have long been used in other countries have now been adopted in China. In addition, skin flaps from the forearm, upper arm and thigh are used now.

With the steady increase in Chinese living standards have come demands for cosmetic surgery. But Professor Song said that these operations are at present limited to the reconstruction of eyelids, noses and breasts.

The Beijing Plastic Surgery Hospital, with a total floor space of 100,000 sq kilometers was founded in the 1950's. It has more than 200 beds and hospitalized some 1,500 patients annually. Many general hospitals in other parts of China have also set up plastic surgery departments.

Professor Song stressed the importance of strengthening basic theory research and personnel training for future plastic surgery work. He told XINHUA that the society plans to promote academic exchanges at home and abroad.

CSO: 4010/96

COMPUTER STORAGE , EDITING OF NUCEIC ACID SEQUENCE DATA

[Article by Yue Shuyun [2867 2885 0061] and Jiang Shouping [3068 1108 1627] of Shanghai Biochemistry Institute, Chinese Academy of Sciences: "Computer Storage and Editing of Nucleic Acid Sequence Data"]

[Text] As the method to determine the sequence of DNA improves in recen years, certain amount of DNA sequence data have already been accumulated. Since the first complete DNA molecule, the ϕx174DNA bacteriophage, was determined in 1977, DNA sequences of bacteria PBR 322, animal virus SV40, and bacteriophages T7, fd, M13, f1 were gradually determined. They are widely used as molecular clone vehicles in genetic engineering. Hence, there is no doubt that the storage of such information on these vehicles in the computer and the insertion and deletion of a certain genetic sequence will be extremely useful in the construction of molecular clone vehicles and analysis of genetic structures. Although the work in this area has just begun, it has already drawn many people's attention and is widely used.[1] Recently, Orcutt et al[2] reported the establishment of a nucleic acid sequence data system in their laboratory. In this paper, the computer program prepared and used for a microprocessor system with capabilities to handle the input, storage and editing (insertion, deletion) of nucleic acid sequence data was introduced. This program has been used to establish a preliminary genetic sequence data bank in our laboratory. Furthermore, it is being used in actual research.

I. Input and Storage of Nucleic Acid Sequence Data and Data Document Structure. We selected the model TRS-80I microprocessor, which has more users in China, and relied on its new operating system to design the program for the input, storage and editing of the sequence data by using the magnetic disk BASIC II language. The storage and editing of nucleic acid sequence data was reliazed through document operation and document retrieval.

The nucleic acid sequence data is stored in a floppy disk in the form of a piece of data document. In order to facilitate the flexible management of the data document, the program uses a random access and storage technique so that the data occupies very little space on the magnetic disk. The reading and writing time is fast. It is easy to modify and

edit the data. EAch data document stored on a floppy disk is composed of several files. During the random storage and access, each file is divided into 8 segments and each segment consists of 30 characters. Hence, 8 subfiles are set up in each files. Because the input sequence data belongs to the serial alphanumerical type, the document buffer is formed in one step. During the execution of the sequence input and storage program (the block diagram of the program is shown in Figure 2), the LSET language is continuously used to place the sequence data, which is input into the internal memory of the machine through the keyboard, into the buffer. When the content of a complete file is stored in the buffer, the buffer content is sent to the magnetic disk for storage.

When the keyboard is used to input the sequence data, subroutines for input by effective symbols were designed, i.e. the users can only input seven symbols A, G, C, T, U, N and @ through the keyboard (the symbol N can represent the undetermined nucleotide group). When the user presses another symbol by mistake, the content will not be input into the internal memory. When the symbol @ is input through the keyboard or when the subsequence punched in is equal to the length of each subfile, the program automatically remind the user to modify the sequence data already in the internal memory. Once an input mistake is found, the position and content to be corrected can easily be typed in to automatically make corrections. When the total length of the sequence typed in by the user is equal to the pre-determined input length, the machine will stop the input and begin a dialogue with the user. If the user is satisfied with the input content, then the buffer is shut off. In the meantime, the input sequence data is stored in a floppy disk under the name specified by the user as a data document.
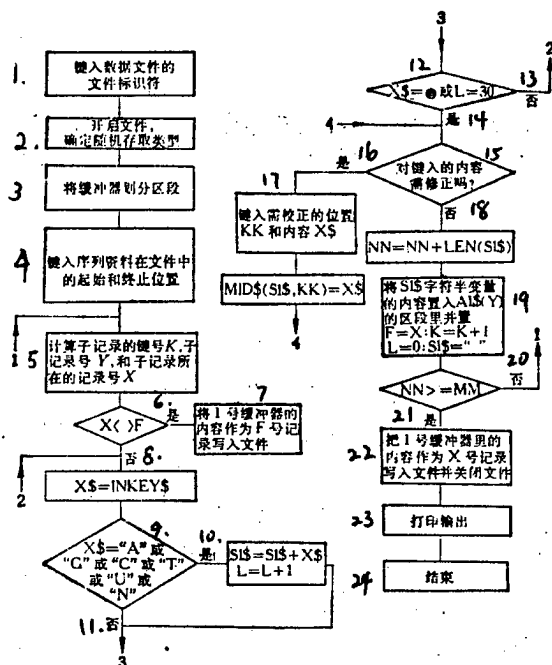

图 1 DNA 序列的输入和存贮程序框图

Figure 1. Block Diagram of Input and Storage Program of the DNA Sequence

[Key to figure 1 on previous page]

1. Type in document identification symbol of the input data
2. Open document and determine machine storage type
3. Devide buffer into sections
4. Type in starting and ending positions of the sequence data in the document
5. Calculate the subfile key K, subfile symbol Y and sumbol of subfile location X
6. Yes
7. Write content in No. 1 buffer as file F in document
8. No
9. x$ = "A" or "G" or "C" or "T" or "U" or "N"
101 Yes
11. No
12. x$ = @ or L = 30
13. No
14. Yes
15. Want to modify input content?
16. Yes
17. Type in position KK and content x$ of correction
18. No
19. Place semi-vailable content of S1$ into section A1$(Y) and set F = X:K = K+.   L = 0:S1$ = " "
20. No
21. Yes
22. Write content in No. 1 buffer as file x in document and close document
23. Print
24. End

II. Editing of Data Document

The editing function is realized by inserting and deleting the content of the sequence by the user. The edited data document can be renamed as a new data document and stored in the genetic sequence bank. When the program enters an insertion mode, the content or insertion is also input into the memory of machine by the user through the keyboard. This content is then recorded on the magnetic disk through a buffer. Similarly, because an input subroutine was designed for effective symbols and the content can be corrected through a dialog between machine and people, the program is convenient to operate. When the program enters a deletion mode, the user only has to type in the beginning position and the length of the sequence to be deleted from the keyboard. The computer will automatically remove this portion of the content. After document editing is completed, the original sequence data document is still stored in the floppy disk. If necessary, the user can compare the sequence information before and after editing through the NASANPR program. The block diagram of the program is shwon in Figure 2.
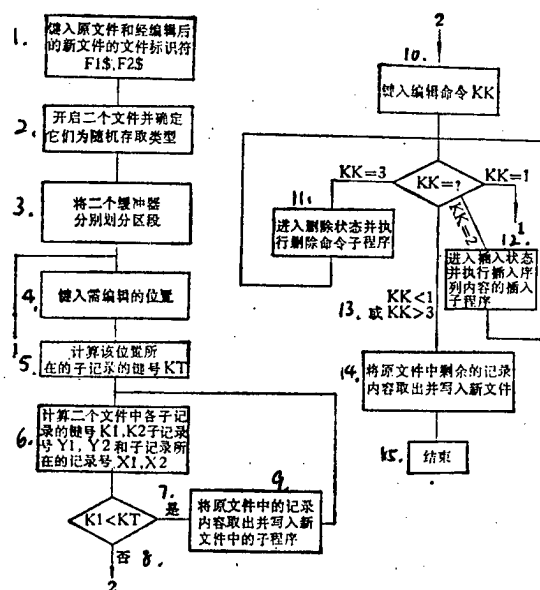
图 2　DNA 序列数据文件的编辑程序简框

Figure 2.　Simplified Block Diagram of the Editing Program of DNA Sequence Data Document

1. Type in the identification symbols of the original and edited documents, F1$, F2$
2. Open both documents and define them as random access type
3. Divide two buffers into sections
4. Type in position to be edited
5. Calculate key sumbol KT of the subfiles at the position
6. Calculate subfile keys K1 and K2, subfile symbol Y1, and Y2 and position symbols of subfiles X1 and X2 in both documents
7. Yes
8. No
9. Take out content in original document and enter into subroutine of new document
10. Type in editing command KK
11. Proceed with deleting and execute deletion subroutine
12. Proceed with inserting and execute insertion subroutine
13. KK = 1 or KK = 3
14. Take remaining record content from original document and enter into new document
15. End

III.　Conclusion

Computer techniques are used in the determination of DNA sequence, recombinant DNA and analysis of high level structure of nucleic acid and genetic structure and have drawn the attention of many people.[3,4] We have used this program on a model TRS-80 microcomputer and entered the complete DNA

sequences of some of bacteria, virus and bacteriophages which are common clone vehicles such as ϕx174[5], SV40[1], PBR322[7] and bacteriophages fd, M13, f1[8], as well as linear human gene sequence[9], hepatitis B virus sequence[10], interferon α chain sequence and DNA β chain[11] sequence into floppy disks to be stored. The nucleic acid sequences stored in the floppy disks can be conveniently analyzed and processed through our nucleic acid sequence management system[12]. We believe that with the build up of the genetic sequence bank and the perfection of the nucleic acid sequence information management system, computers will be extremely useful in the research of genetic engineering.

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